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Insulation Arrangement for Pipes, in Particular for Pipes in a Pneumatic System on a Passenger Aircraft

The invention relates to an insulation arrangement for pipes, especially for pipes of a pneumatic system in a passenger transport aircraft.

Due to the high temperatures of up to 260°C, it is necessary to carry out a heat insulation for pneumatic pipes in a passenger transport aircraft, and to protect structural components of the aircraft against the high temperatures. In Airbus aircraft, titanium foils with a thickness of approximately 0.1 mm are used for such insulations, as an outer sleeve or sheath enclosing two layers of fiberglass wool with a thickness of respectively one inch. Z-profiles are welded onto the ends of the corresponding pipe, whereby these Z-profiles on the one hand form the longitudinal boundary for the fiberglass wool layers and on the other hand serve as a carrier for the titanium outer sheath. The titanium outer sheath is welded onto the Z-profile. Such a pipe installation is costly and complicated in handling, because, among other things, before the welding of the titanium outer sheath, two plies of insulation layer must be applied onto the pipe and thereafter the titanium foil is welded onto the Z-profile. Such an insulation arrangement is also no longer removable from the pipe. If damages should arise on the insulation, for example through mechanical influences, which

cause a denting or tearing of the insulation, a repair is not possible and a costly exchange of the entire pipe must be taken into consideration.

It is thus the underlying object of the present invention to provide a pipe insulation of the above mentioned general type, which is suitable for use on pneumatic pipes for passenger transport aircraft in a corresponding lightweight construction, is not costly or complicated to install, and offers an economical and uncomplicated repair possibility for small damages on the titanium outer sheath.

This object is achieved according to the invention by the measures identified in the patent claim 1.

In that regard, according to claim 1, it is especially advantageous that such an insulation arrangement is easily producible in a pre-assembly, and an installation on the pneumatic pipeline system can be carried out quickly and in an uncomplicated manner. The lightweight and temperature resistant embodiment of the insulation arrangement enables the application in the pneumatic system of an aircraft. With the provided shell technology, the insulation can be separately disassembled and removed, and if necessary, damaged insulation parts can be exchanged in an economical and uncomplicated manner.

Further developments and advantageous embodiments are set forth in the claims 2 to 10.

The insulation arrangement according to claims 2, 3 or 4 respectively exhibits a simple possibility of realizing a shell technology in which the insulation material can be inserted.

With the measures according to claim 5 or 6, a preferred and secure possibility of the closing of the longitudinal seam is provided.

The measure according to claim 7 is provided for achieving a lightweight construction, with which the strength of the outer sheath being used can be increased.

Advantageous measures for ensuring a monitoring system against leaks in the pipeline system are identified in the claims 8 and 9.

Especially in connection with long or curved pipe sections, the insertion of strengthening elements according to the claim 10 is advantageous, in order to achieve a sufficient stability of the insulation arrangement.

Further details and advantages arise from the following description of example embodiments of the invention.

Example embodiments of the invention are illustrated in the drawing, and are described in further detail in the following with reference to the Figures 1 to 7. In the Figures, the same components are provided with the same reference numbers.

In detail, it is shown by:

Fig. 1 an insulation arrangement according to the invention for pneumatic pipes in a top plan view,

Fig. 2 an enlarged detail illustration of the surface of the outer sheath of the pipe insulation,

Fig. 3 a detail illustration of the connection or junction between Z-profile and titanium foil provided on the insulation arrangement,

Fig. 4 a cross section through a pneumatic pipe with the inventive insulation arrangement according to section AA of Fig. 1,

Fig. 5A,B detail illustrations in the area of a longitudinal seam of the insulation arrangement,

Fig. 6A,B a detail illustration with an enlarged sectional illustration of the outlet holes provided in the insulation arrangement, and

Fig. 7A,B,C embodiments of stiffening elements within the insulation arrangement.

An insulation arrangement 1 for pipes 2 can be seen in Fig. 1. The pipes 2 are preferably provided as pneumatic pipes in a passenger transport aircraft and are thermally insulated with insulation layers 6 preferably consisting of fiberglass wool, due to the arising high temperatures of an airstream up to 260°C in the interior of the pipe. Thereby, the surrounding aircraft structure is protected against a too-high heat radiation of the pipes 2. It is an essential requirement for the insulation arrangement 1 to be carried out in a lightweight manner of construction. Thus, a titanium foil 31 with a thickness of approximately 0.1 mm is used as an outer sleeve or sheath 3 of the insulation. In Fig. 2 it is shown that the titanium foil 31 comprises a profiled or patterned configuration 4 in order to increase the stiffness of the outer sheath.

Visible in Fig. 1 are two pipe sections 21 and 22, whereby the pipe section 22 is embodied curved. The pipe sections 21, 22 and further pipe sections not shown are joined together to form a pneumatic pipeline system, preferably by means of flange connections or joints. After the installation of the pipe sections 21, 22, the insulation arrangement 1 is mounted or installed on the pipe 2. The insulation arrangement 1 is preferably embodied as a shell, whereby a half shell (not shown) or a full shell 9 can be provided. The full shell 9 comprises a longitudinal seam 13 in the titanium outer sheath 3; for a half shell, two longitudinal seams would be necessary. The titanium foil 31 comprises dimensions corresponding to the circumference of the necessary outer sheath 3 for the shell 9 of a pipe section

21 or 22. In a first method step, the end sections 32 and 33 are connected with a Z-profile 7 (see detail illustration in Fig. 3). Also other typical profile shapes are utilizable. The titanium foil 31 is welded onto the upper web or leg 71 of the Z-profile 7. Due to the Z-shape of the termination profile 7, a receiver for an insulation layer 6 is formed with the middle leg or web 72 and the lower leg or web 73. Fiberglass wool is preferably used as the insulation material. After the completion of the connections or joints between the Z-profile 7 on the respective end section 32 and 33, the insulation layer 6 can be inserted in or laid into the formed shell 9. If it is necessary, the insulation layer 6 can be secured or fixed on the inner side of the titanium foil 31 with a temperature resistant adhesive. The thusly pre-assembled shell 9 is now ready for the installation on the pneumatic pipe 2, and, by opening the longitudinal seam 13, is pushed or slipped over the pipe 2, and is closed in the area of the longitudinal seam by welding or adhesive bonding or gluing. Thereby, the installation effort on location can be considerably reduced, and the installation can be simplified. The closing of the longitudinal seam 13 is explained in the subsequent following Figures 4 and 5.

A cross section of an insulation arrangement 1 in the embodiment as a full shell 9 is shown in Fig. 4. The cross section corresponds to the section A-A from Fig. 1. The full shell 9 is opened and closed in the area of the longitudinal seam 13. The area of the longitudinal seam 13 is shown as a detail in Fig. 5. In Fig. 5A it can be seen that joint webs 14 and 14' are arranged

on the butting-together longitudinal seam 13 on the outer sheath 3, which joint webs serve for the closing of the longitudinal seam 13. The joint webs 14, 14' are connected by gluing or adhesive bonding, pulse welding, or other welding methods, and according to Fig. 5B a securing web 15 can finally be bent according to the arrow direction as a form-locking connection and thereby additionally secure the two joint webs 14, 14' against opening.

It is furthermore visible in Fig. 1 in connection with Fig. 4, that warning wires 11 of a monitoring system, a so-called "Overheat Detection System" against possible leaks in the pneumatic pipeline system, are secured on the titanium outer sheath 3 by means of mounting brackets 10. The mounting brackets 10 are preferably welded onto the titanium outer sheath 3. The warning wires 11 extend along the pneumatic pipe 2 and are positioned above outlet holes 5. The arrangement of the outlet holes 5 in the titanium foil 31 is shown as a detail in Fig. 6.

Fig. 6A shows a top plan view onto the titanium outer sheath 3 in the area of the outlet holes, in Fig. 6B a cross section is visible in a sectional view, which shows the titanium foil 31 with the outlet holes 5. In the event of a possible leak, hot air flows through the insulation layer 6 into the outlet holes 5 that are closest to the leak. The warning wires positioned above the outlet holes 5 become hot, and upon overheating emit a signal, whereby the position of an arising leak can be exactly detected.

In order to guarantee the functionality of the monitoring system, it must be ensured that the warning wires 11 are respectively positioned directly above the outlet holes 5. For that it can be necessary to provide an anti-rotation securement 8 between the pneumatic pipe 5 and the shell 9, because otherwise the insulation arrangement 1 can be freely moved on the pipe 2. In the detail illustration of Fig. 3, it is shown that such a connection is realized by means of a fillet joint seam 81 of a temperature resistant adhesive or a paste between the Z-profile 7 in the end region 32 or 33 of a titanium sheath 3 and the pipe 2. The fillet joint seams 81 can be approximately 50 mm long and can be placed at several locations of the circumference between the Z-profile 7 and the pipe 2.

If now an exchange of the insulation 1 becomes necessary, for example in the event of possible damages of the titanium foil 31, the anti-rotation securement 8 is to be released and the longitudinal seam 13 is to be opened. The insulation 1 can be removed from the corresponding pipe section 21 or 22 in an uncomplicated economical manner and can be replaced with an exchange or replacement part. After the closing of the longitudinal seam of the replacement insulation, the repair is finished, and if necessary a new fillet joint seam 81 is applied as an anti-rotation securement 8 between the titanium outer sheath 3 and the pipe 2.

Embodiments of stiffening elements 12 are shown in Fig. 7, which stiffening elements can be used for reinforcement or

strengthening of the titanium outer sheath 3, especially in connection with longer pipe sections 21 or in curved pipe sections 22. Such stiffening elements can be embodied preferably as L-profiles 121 (see Fig. 7A), as U-profiles 122 (see Fig. 7B) or also as corrugations or beads 123 (see Fig. 7C). They are welded onto the inner side of the titanium sheath 3 or inserted into the foil 31. It is provided to use such stiffening elements 12 partially as needed.